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GIFFORD PINCHOT, Forester.

THE PRESERVATIVE TREATMENT OF FENCE POSTS.

By

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INTRODUCTION.

Satisfactory fence posts are each year more difficult to secure. Substitutes, such as reenforced concrete and iron, are probably too costly to compete with wooden posts, and the only solution of the difficulty lies in the use of cheaper woods and in preventing decay by preservative treatment.

Statistics do not show the actual consumption of wood for fence posts in the United States. The cut of posts by logging and timber camps in 1900 was given by the Twelfth Census as 8,715,000, valued at $606,000, and in 1906 the Northwestern Cedarmen's Association reported a cut of 15,200,000 cedar posts in the Lake States, Michigan, Wisconsin, and Minnesota. Neither of these estimates, however, includes the posts cut by farmers from their own woodlots, which far exceed in number the posts sold. The total cut is therefore very large.

The more expensive kinds of wood, such as white oak and cedar, which have long been used for posts, are now too scarce and too much in demand for other uses to allow of their meeting the demand for posts.[a] Fortunately most of the so-called "inferior" woods are well adapted to preservative treatment. This is especially true of the cottonwoods, aspens, willows, sycamore, low-grade pines, and some of the gums. When properly treated these woods will outlast the best grades of untreated timber and are therefore cheaper and more satisfactory. It is the purpose of this circular to show how fence posts may be treated and with what results.

CAUSES OF DECAY.

To appreciate the value of any preservative treatment, it is necessary to know what causes decay, and how a preservative treatment tends to prevent it. Briefly, decay in timber is caused by the action

[a] In certain regions it is a paying investment to plant rapid-growing trees, like black locust and catalpa, especially for posts. Information on this subject is given in publications of the Forest Service which deal with forest extension and replacement.

of bacteria and fungi—low forms of plants—which require for their development definite amounts of air, water, heat, and food. If one or more of these factors can be eliminated in whole or in part, bacteria and fungi will not develop and the wood will not readily decay.

It is well known that wood decays first where it comes in contact with the ground. This is because the fungi find there the conditions most favorable for their growth. Protection is therefore most needed at this point. When wood is fully exposed to the air, as in the tops of posts, the moisture is rapidly evaporated and decay is very slow. In the case of some woods, however, such as cottonwood and maple, a treatment of the top is necessary.

PRESERVATIVE METHODS IN USE.

A number of more or less crude methods have been tried for prolonging the life of fence posts. These have brought out certain points which may prove of value if more efficient treatment can not be undertaken. Chief of these are the following:

A seasoned post is better than a green post; hence posts should be as dry as possible before being set.

Setting a post small end down does not check its decay.

By piling stones around the base of the post or setting it in masonry or concrete, vegetation is kept away, better drainage is secured, and the post is kept drier. The slight gain thus secured does not, however, justify the cost.

Charring the butt of the post, if properly done, gives good results. Only thoroughly dry posts should be charred, and the charred surface should extend at least 6 inches above the ground line.

Soaking the posts in a solution of copper sulphate is not recommended, since this salt is too soluble, and will therefore more quickly leach out. Soaking in mercuric chlorid takes so long that it can not be recommended to farmers or ranchmen. This solution, moreover, is extremely poisonous and must be handled with great care.

Good results are sometimes obtained by boring holes diagonally into the posts just above the ground line and filling them with some preservative solution, such as various forms of coal tar. This method gives the best results with soft woods, like sycamore and cottonwood. Boring the holes, however, weakens the posts.

If the butt of a post is painted with or plunged into a hot solution of carbolineum or creosote, very good results can be obtained. The posts should be thoroughly dry, in order to prevent internal decay and exposure of the inner untreated wood by checking. Next to impregnation with these materials, this method is doubtless the best.

Creosote[a] has been used for preserving wood since 1838. Timbers impregnated with it have had their durability increased tenfold.

EXPERIMENTS BY THE FOREST SERVICE.

DESCRIPTION OF THE EXPERIMENTS.

The first experiments by the Forest Service in creosoting fence posts in this country were made in cooperation with the Bureau of Plant Industry during the Louisiana Purchase Exposition, at St. Louis, in 1904. Posts cut from maple, elm, sycamore, ash, cottonwood, sassafras, hickory, black walnut, water oak, willow, and red oak were treated. Experiments were afterwards made at Ellwood and Los Angeles, Cal., with blue, red, and sugar gums and ironbark—all species of eucalyptus. As in all first experiments, the results were chiefly valuable in indicating the right direction for later work.

In November, 1906, experiments were made at St. Anthony, Idaho, in treating fence posts cut from fire-killed lodgepole pine. One of the objects of this work was to test further the points brought out but left inconclusive in the previous experiments. The number of posts used in some of the St. Louis tests was too small to yield reliable averages. Wood of the same species is very variable, even when grown, cut, and seasoned under the same conditions, so that two pieces may be given exactly the same treatment and yet show different absorptions and penetrations. To define the effect of any particular treatment it is necessary, therefore, to average the results of many tests. The experiments at St. Anthony were arranged with the object of determining how absorption and penetration are affected by—

(1) The temperature of the creosote.
(2) The duration of the bath in hot creosote.
(3) The duration of the bath in the creosote as it cools, after the heat has been shut off.

The experiments were divided into three series, as follows:

Series A.—To determine the minimum efficient temperature for the hot creosote, so as to reduce the vaporization of the creosote and the consumption of fuel.

Series B.—To determine the minimum efficient duration of the bath in hot creosote, so as to reduce the vaporization of the oil, the consumption of fuel, and time of treatment.

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[a] By creosote is meant dead oil of coal tar. In the making of coal gas, coal is subjected to high heat without the presence of sufficient air to permit combustion. This process gives two main products—illuminating gas and coal tar. The coal tar is then distilled and separated into the light oils, the dead oils (creosote), and pitch. Creosote can be obtained by the barrel in many of the larger cities of the United States.

Series C.—To determine the minimum efficient duration of immersion in the creosote after shutting off the heat, so as to economize time in treatment.

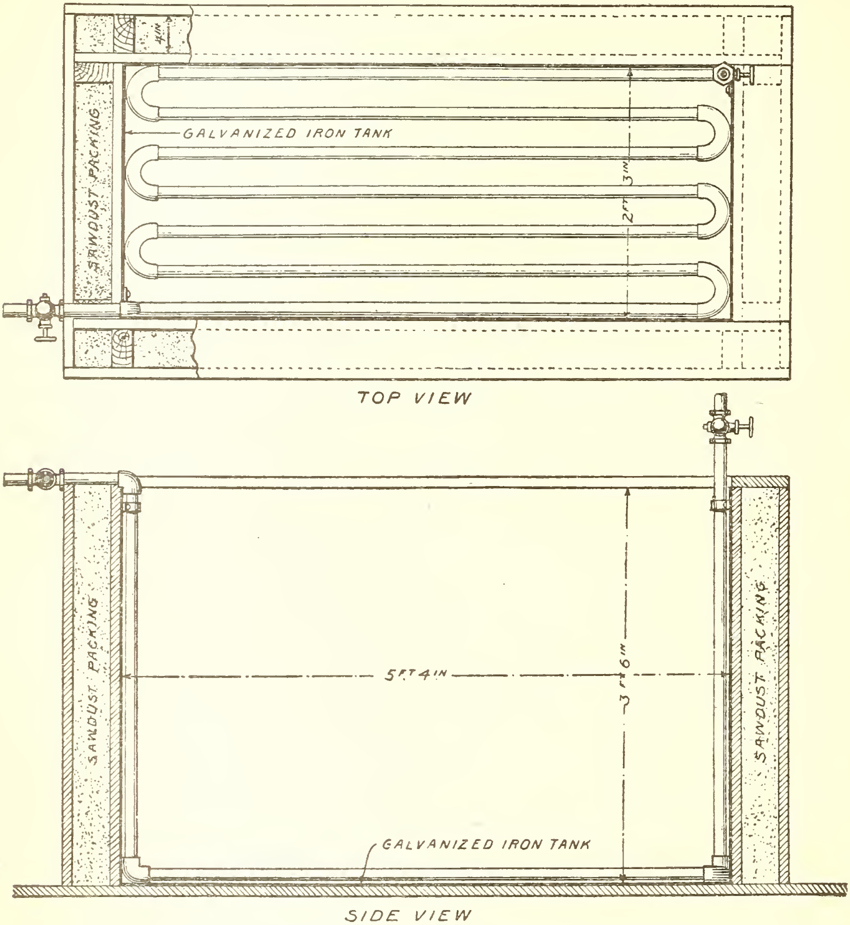

FIG. 1.—Diagram of an experimental tank used for treating fence posts.

The results of these tests are given on page 11.

Apparatus used.—In the experiments at St. Louis and in California the apparatus used consisted of a cylindrical tank made of $\frac{3}{16}$-inch sheet iron, about 4 feet in diameter and 4 feet in depth, with a perforated iron plate in the bottom. The tank was built on the side of a hill in order to facilitate the handling of the posts, and was set upon brick piers so that a fire could be built under it. Creosote was then

poured into the tank and the posts were placed in it. The total cost of such a tank is about $45.

The apparatus used at St. Anthony (fig. 1) consisted of a rectangular galvanized-iron tank 5 feet 4 inches long, 2 feet 3 inches wide, and 3 feet 6 inches high. This tank was set snugly into a wooden box built of 1-inch planks and open at the top. The object of this box was to keep the tank from bulging when filled with creosote, to protect the tank from injury, and to keep the creosote from cooling too rapidly. When the posts are treated in winter or in cold regions it is best to build an additional casing around the inner box, leaving a space of about 4 inches between them, and firmly packing this space with sawdust. The creosote will then seldom solidify over night and may be more quickly heated.

The creosote was heated by fitting a series of seven 1-inch steam pipes in the bottom of the tank, coupled to the boiler of an engine. The amount of steam passing through the pipes was controlled by two valves—one placed between the tank and the boiler, to regulate the amount of steam entering the coils, and the other at the outlet of the coils to control the pressure. By raising or lowering the pressure of steam in the coils the creosote could be heated to any temperature desired. An apparatus of this kind makes it possible to keep the temperature of the creosote fairly constant, and gives very satisfactory results. It can of course be used only when some kind of steam boiler is available. It costs about $30.

Tanks similar to those described give best results, but if means are not available for their construction an old iron boiler or like vessel can be used. The essential requirements are that the creosote shall be heated in the vessel to about 215° F., and that the butts of the posts shall be submerged up to about 6 inches above their ground line. In special cases, where a thorough top treatment is necessary, the vessel should be of sufficient size to allow the whole post to be submerged.

RESULTS.

The Forest Service has so far experimented with 18 kinds of wood cut for fence posts. In the accompanying table the species are arranged in five groups, according to the manner in which they absorbed the creosote during the experimental treatments. The posts, in all cases, are peeled. By hot creosote is meant that which has a temperature of about 215° F.

TABLE 1.—*Results of treating fence posts.*

[All of the posts were round, except the sycamore and cottonwood, part of which were split.]

GROUP I.

Species.	Condition.	Hours in hot creosote.	Hours in cold creosote.	Resulting penetration.
				Inches.
Blue gum (Eucalyptus)	Green	2	0	(a)
Red gum (Eucalyptus)	....do	2	0	(a)
Sugar gum (Eucalyptus)	....do	2	0	(a)
Ironbark (Eucalyptus)	....do	2	0	(a)

GROUP II.

Species.	Condition.	Hours in hot creosote.	Hours in cold creosote.	Resulting penetration.
Sassafras	Seasoned	6	12	0.3
Ash	....do	6	12	.4
Hickory	....do	6	12	.3
Red oak	....do	6	12	.3
Water oak [b]	....do	6	12	.3
Elm	....do	6	12	.4
Maple [b]	....do	6	12	.5

GROUP III.

Species.	Condition.	Hours in hot creosote.	Hours in cold creosote.	Resulting penetration.
Douglas fir	Seasoned	5	12	0.7
Quaking aspen [b]	....do	5	12	.8
Black walnut	....do	5	12	1.2

GROUP IV.

Species.	Condition.	Hours in hot creosote.	Hours in cold creosote.	Resulting penetration.
Willow	Green	4	12	0.3

GROUP V.

Species.	Condition.	Hours in hot creosote.	Hours in cold creosote.	Resulting penetration.
Sycamore [b]	Seasoned	2	12	1.5
Cottonwood [b]	....do	2	12	1.5
Lodgepole pine	....do	½	12	1.25
Do	....do	1	6	1.25

[a] In posts of the species shown in Group I the creosote will be found principally in the pith rays and the tubes called "vascular ducts." It is best to stand these posts butt up after treatment, so that the free oil in them will run toward the top.

[b] Water oak and maple of Group II, quaking aspen of Group III, willow of Group IV, and sycamore and cottonwood of Group V should be given top treatment.

The heartwood of sycamore and cottonwood takes treatment readily, and posts of these woods may therefore be either round or split.

A post may be top-treated by simply plunging its top into hot creosote, or by applying creosote with a brush, like paint. The former method, however, is better, because it allows the creosote to penetrate all the season checks, and any surplus creosote runs back into the tank and is used again. The brush form of top treatment should not be given while either the wood or the air is cold, because the creosote will then simply harden upon the surface instead of pentrating into the

wood. If the decay in the top is very rapid, as in the loblolly pine posts in the South, the best results are obtained by impregnating the whole post with creosote. In such cases the heating tank should be of such size that, when filled with creosote, the posts will be completely submerged.

The results of the series of tests outlined on pages 7 and 8, which show the effect of the temperature of the hot creosote and of the duration of the baths in hot and in cold cresote, are given in Table 2.

TABLE 2.—*Effects of the temperature and the duration of treatment on posts of fire-killed lodgepole pine.*

Series.	Run No.	Temperature of hot creosote.	Immersion in hot creosote.	Immersion in cold creosote.	Consumption of creosote.		Penetration.	Number of posts treated.
					Per post.	Per cubic foot		
		° F.	*Hours.*	*Hours.*	*Galls.*	~~*Lbs.*~~ Galls	*Inches.*	
A [a]	1	230	8	14	1.52	6.22	2.9	32
	2	205	8	14	1.52	2.96	2.0	30
B [b]	1	205	4	14	1.41	3.37	2.3	30
	2	200	2	14	1.21	3.98	2.7	48
	3	194	1	14	1.05	2.67	2.3	40
	4	196	½	14	.74	1.86	1.6	43
C [c]	1	192	1	38	1.06	2.75	2.0	39
	2	192	1	14	1.48	2.42	2.0	32
	3	180	1	6	.86	1.48	1.9	32

[a] To test the effect of temperature.
[b] To test the effect of the duration of the bath in hot creosote.
[c] To test the effect of the duration of the bath in cooling creosote, the heat being shut off and the creosote being allowed to cool gradually.

Series A shows that the hotter the creosote the greater the absorption and penetration. Series B shows that within fixed limits increased duration of the bath in hot creosote (other factors being equal) gives greater absorption and penetration. Series C shows that the same holds true for cooling creosote. The table shows that there is no exact relation between penetration and absorption. A detailed discussion of the causes for this or the determination of the controlling factors would be chiefly theoretical and hence is not included here.

The object of these tests, as has been said, was to find a commercial treatment which could be recommended. With the average penetration fixed at about 1¾ inches, this is found in run number 4 in Series B and run number 3 in Series C.

It should be remembered that the creosote used in this experiment contained a large amount of naphthalene, a substance which easily vaporizes, so that the consumption would be materially smaller than that here given if a heavier grade of creosote were used.

A point not conclusively tested in any of the experiments to date is the effect of a long period in hot creosote with a short period in cold creosote. It is claimed that this operation will give the most

economical treatment, because the rarefication of the air in the wood cells will be greater both in degree and in amount, which will cause a strong vacuum resulting in a maximum depth of penetration for a given amount of creosote absorbed. This method of treatment may prove very valuable where a heavy grade of creosote is obtainable, particularly in localities where fuel is cheap.

COST OF TREATMENT.

The total cost of treated fence posts varies so much in different regions that general figures are out of the question. Since the users of fence posts in various parts of the country know the cost of untreated posts, only estimates on the cost of treatment must suffice. If the determining factors are known the cost of treatment in any locality can easily be estimated.

The cost depends upon the cost of the apparatus, the price of labor, the number of posts treated per day, the absorption of creosote per post, and the cost of creosote.

The cost of the apparatus may be merely nominal if an old boiler is used. An apparatus like that used in the experiments costs from $30 to $45.

The price of labor varies with the locality. It can easily be ascertained.

The number of posts that can be treated per day depends upon the size of the tank and the size and form of the posts. In general, a tank with a bottom 12 square feet in area will hold between 40 and 50 posts 6 inches in diameter at the butt. With such a tank this number of posts would be the daily capacity, except with lodgepole pine posts, with which two runs per day can be made.

The absorption of creosote per post for the species included in Table 1 is about as follows: Group I, $\frac{1}{10}$ gallon; Group II, $\frac{4}{10}$ gallon; Group III, $\frac{6}{10}$ gallon; Group IV, $\frac{2}{10}$ gallon; Group V, $\frac{7}{10}$ gallon.

The price of creosote varies at present from 10 cents per gallon in the East and Middle West to 27 cents per gallon in the Rocky Mountain States. On the Pacific coast it is about 16 cents per gallon.

If a man does the work himself, or in cooperation with his neighbors, the cost per post will, of course, be much less.

In general, the cost of treating a post will vary from 4 to 15 cents, depending upon the factors just given. In order to get the total cost of a treated post, the cost of the treatment must, of course, be added to the cost of the post. A post properly treated should give service for at least twenty years. To indicate more clearly the

advantage of treating, from the standpoint of the consumer, the following example from Idaho is given:

TABLE 3.—*Comparative costs of untreated and treated posts of lodgepole pine in Idaho.*

	Untreated.	Treated.
Initial cost of post	\$0.06	\$0.06
Cost of treating post	.00	.15
Estimated cost of setting post	.12	.12
Total cost of set post	.18	.33
Estimated length of service ... years	4	20
Annual cost of post (allowing 6 per cent interest on investment) approximately	\$0.05	\$0.03

In this table the treatment approximately corresponds to that given in run 4 of Series B and run 3 of Series C, Table 2, where the average penetration of the creosote is about 1¾ inches and the cost of the creosote about 20 cents per gallon. One man can treat each day 100 lodgepole pine posts with a 6-inch top diameter in a tank similar to that shown in figure 1. The cost of the tank and fuel is not included in Table 3, for they are altogether too variable. These items, however, are seldom large enough to affect materially the comparison of cost. The estimated costs given in both cases are based upon the time taken in fencing, assuming that all work is paid for and not done by the owner.

It can be seen that the annual saving is about 2 cents, so that at the end of twenty years, with conditions similar to those given in the example, a creosoted fence will be about 40 cents per post cheaper than one untreated. A table of cost like the above is necessarily very crude, since the factors composing it are extremely variable, but it tends to impress somewhat forcibly the saving effected by the use of treated posts, even though their initial cost is high.

CONCLUSIONS.

The principles which follow are of general application in fence-post treatment. Local conditions, of course, may require the operator to modify them somewhat to meet his particular requirements.

SELECTION AND PREPARATION OF POSTS.

The resistance of all treated posts to decay is alike, regardless of the kind of wood used; hence only the cheaper woods should be used, and the more valuable kinds should be saved for other purposes. Since sapwood can be impregnated better than heartwood, posts with much sapwood are the best.

Posts cut from woods whose heartwood can not be treated (see Table 1) are best left round. When the heartwood takes treatment readily either round or split posts may be used.

Posts should be air dry before they are treated or set. They should be cut at least a month before treatment. Wood dries fastest in spring or summer, but with those species which check badly, such as the oaks, cutting is best done in autumn or early winter.

Even the inner bark should be removed before the posts are treated or set, especially from that part of the post submerged in the creosote. Bark reduces the penetration of creosote into the wood, besides itself absorbing the creosote without increasing the durability of the post.

The tops of posts should be cut slanting, preferably with an ax, so that rain water will not remain on them. When they are cut with a saw the pitch should be greater, especially in posts in which there is a marked difference in hardness between the springwood and the summerwood.

TREATMENT.

If butt treatments in the open tank can not be given, and yet some preservative method is desired, plunge the butts of the posts into a vessel of hot creosote or carbolineum, or apply either liquid with a brush. Application of any of the methods mentioned on page 6 will tend to make the posts more durable than they would be if set green.

Whenever possible use an apparatus similar to the one described on page 9 for open-tank treatments.

Use as heavy a grade of creosote as can be obtained.

Aim to get the creosote to soak as far into the posts as possible. With woods having shallow sapwood (about one-half inch deep) treat all the sapwood. With woods having deep sapwood, or with heartwood that takes treatment readily, secure a penetration of at least 1 inch. The heartwood of very few species can be treated. For this reason round posts are better than split posts, since a penetration is obtained entirely around them. Species with a deep sapwood, like lodgepole pine, will absorb much more creosote than species with shallow sapwood, like chestnut.

A long bath in hot creosote, followed by a shorter one in cold creosote, will probably give best results. Usually, woods with a porous structure, like the poplars, can be treated more easily than dense woods, like the oaks, and hence need not be left in the creosote for so long a time.

Never heat the creosote above 250° F. In most cases a temperature just above the boiling point of water is best. Heating the creo-

sote above 250° F. weakens the wood and causes a large amount of creosote to vaporize.

Never brush-treat posts when the air or the post is so cold that the creosote simply solidifies on the surface of the post.

Keep the posts as dry as possible before treatment, and keep rain and snow out of the tank by roofing it, if necessary.

Approved:

JAMES WILSON, *Secretary.*

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